WCAP-15831-P
Project 694

May 17, 2004

WOG-04-257

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Attn: Chief, Information Management Branch
Division of Program Management

Subject: Response to Clarification Request - WCAP-15831-P "WOG Risk Informed ATWS Assessment and Licensing Implementation Process"

References:

1. Transmittal of Reports: WCAP-15831-P, Rev 0 (Proprietary) and WCAP – 15831-NP, Rev. 0, (Non-Proprietary), Entitled "WOG Risk-Informed ATWS Assessment and Licensing Implementation Process" (MUHP-1033), OG-02-027, dated July 23, 2002.

2. Request for Additional Information Regarding WCAP-15831-P, "WOG Risk-Informed ATWS Assessment and Licensing Implementation Process" (TAC No. MB5751), fax dated July 24, 2003.

3. Clarification to WCAP-15831-P "WOG Risk Informed ATWS Assessment and Licensing Implementation Process", WOG-03-664, dated December 30, 2003.

4. "WCAP-15831-P, "WOG Risk-Informed ATWS Assessment and Licensing Implementation Process," July 2002 – Withdrawal of Previous Request for Additional Information (RAI) and Request for Further Clarifications Needed to Revise the Topical Report (TAC NO. MB5751)", dated March 25, 2004.

Westinghouse Electric Company LLC (Westinghouse) on behalf of the Westinghouse Owners Group (WOG) submitted WCAP-15831-P, Rev 0 for approval in July 2002, (Ref. 1). By letter dated August 25, 2003, the Nuclear Regulatory Commission (NRC) issued a Request for Additional Information (RAI) for WCAP-15831-P, Rev 0 "WOG Risk-Informed ATWS Assessment and Licensing Implementation Process," (Ref. 2).

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The NRC Staff and the Westinghouse Owners Group met on December 11, 2003 to discuss the RAIs that the Staff provided to the WOG on WCAP-15831-P, Rev 0 "WOG Risk-Informed ATWS Assessment and Licensing Implementation Process". The Staff indicated that a number of the RAIs provided on the WCAP were a result of the second approach, presented in Section 7 of the WCAP, to address the requirement for a configuration management program. The Staff stated in the letter transmitting the RAIs on the WCAP, and also at the December 11, 2003 meeting, that they considered the second approach to be a risk based approach and found that it was unacceptable since it did not address defense-in-depth. The WOG agreed to eliminate this approach and will delete it from the WCAP in Revision 1 (Ref. 3). Based on the WOGs action to eliminate the risk based approach, the NRC retracted the current set of RAIs and issued a much smaller set of comments directed at further developing and implementing a configuration management program with the purpose of maintaining defense-in-depth (Ref. 4).

The purpose of this letter is to transmit responses to the staff's request for further clarifications (Enclosure 1). In addition, responses are provided to three additional clarifications identified at the NRC/WOG meeting on the WCAP on March 16, 2004. Per agreement at the March 16, 2004 meeting, the Staff indicated they would reply to the WOG concerning the adequacy of the clarifying information within two weeks of receiving the responses. The WOG looks forward to discussing this information with the Staff in early June.

If you require further information, please feel free to contact Mr. Jim Molkenthin in the Owners Group Program Management Office at (860) 731-6727.

Sincerely,

Frederick. P. "Ted" Schiffley, II
Chairman
Westinghouse Owners Group

Enclosures (1)

cc: Management Committee
Analysis Subcommittee
Licensing Subcommittee
Project Management Office
C. Brinkman, (W)
G. Andre, (W)
G. Ament, (W)
J. Andrachek, (W)
R. Ankney, (W)
E. Monahan (W)
S. Dembek, NRC
R. Linthicum, Exelon
G. Shulka, NRC

Response to NRC's Request for Further Clarifications

TECHNICAL

Technical Clarification 1. To respond to the staff's concern about the potential degradation of defense-in-depth, Section 7 of WCAP-15831-P discusses an anticipated transient without scram (ATWS) configuration management approach (i.e., Approach 1) that can be implemented by utilities. The topical report (TR) provided limited details regarding the development and implementation of this approach. During meetings with the Westinghouse Owners Group (WOG), the staff agreed to review a detailed description of this approach for ensuring defense-in-depth capabilities. The staff has compiled the following topics that the WOG should address in its revision to WCAP-15831-P.

Technical Clarification 1.a. The ATWS configuration management program should have as its fundamental goal, minimizing unfavorable exposure time (UET) conditions at Westinghouse plants. The TR should describe how this program will be managed, controlled, implemented, and verified to ensure UETs are minimized.

Response: The objective of the ATWS Configuration Management Program (CMP) is to operate the plant in a configuration that maintains defense-in-depth to ATWS events, that is, the configuration is favorable to ATWS pressure transient mitigation. It is acceptable to operate in an unfavorable configuration, prior to implementing compensatory actions, for a cumulative time that will be specified as part of the ATWS CMP.

The details of the ATWS CMP, with regard to how this program will be managed, controlled, implemented, and verified, will be specified on a plant specific basis. The revision to the WCAP will provide high level guidance that will be followed by licensees to ensure the plant is operating in favorable ATWS configurations, consistent with the time in the cycle, and implementing appropriate compensatory actions if the cumulative unfavorable configuration time exceeds an acceptable limit. The WCAP will specify acceptable compensatory actions and the cumulative time a plant is allowed to operate in unfavorable conditions, in addition to implementation requirements to ensure the program is managed and controlled appropriately. The WCAP will also provide the detailed approach for calculating unfavorable exposure times.

In general, the ATWS CMP will have the following key characteristics.

ATWS CMP Key Characteristics

Plants will be divided into the following three groups based on consistency with the ATWS Rule and if the plant has a diverse scram system (DSS).

- Group 1: Plants with a DSS
- Group 2: Plants without a DSS, consistent with the ATWS Rule (installed AMSAC) and the basis for the ATWS Rule

- Group 3: Plants without a DSS, consistent with the ATWS Rule (installed AMSAC), but not the basis for the ATWS Rule

A plant consistent with the basis for the ATWS Rule will have either:

- a core design limit on UET of < 5% for the ATWS Rule reference configuration/condition of no control rod insertion, all auxiliary feedwater (AFW) available, and no PORVs blocked, or
- an MTC of < -8 pcm/°F for 95% of the cycle.

Plants in Groups 1 or 2 will not be required to implement the ATWS CMP.

The ATWS CMP key characteristics are divided into three areas; overall structure and administrative control, compensatory actions, and time allowed in an unfavorable condition. Each is discussed in the following paragraphs.

Overall CMP Structure and Administrative Control

By controlling the plant configuration, plants can maintain ATWS defense-in-depth capabilities. Plants can manipulate the plant configuration to ensure they are operating with favorable conditions with regard to UETs, and therefore ATWS events, by limiting the unavailability of systems important to ATWS event mitigation. Limitations on plant configuration vary depending on the time in the cycle and become less restrictive further into the cycle.

Configuration restrictions are proposed to address possible degradation of defense-in-depth. The time in life when the plant mitigation systems cannot relieve sufficient RCS pressure is dependent on core design, time in core life, and the availability of control rod insertion, pressure relief, and AFW. Table 7-1 of the WCAP presents UET information for a high reactivity core in the form of acceptable plant configurations for different times during the fuel cycle. This was developed from the UETs provided on Tables 4-7 and 4-8 of the WCAP. In this case, defense-in-depth is the basis for acceptable configurations. This table defines the plant configurations required to maintain defense-in-depth, with regard to ATWS, at different times in the cycle. The information in this table can be used to schedule acceptable times for removal of equipment from service. It should be noted that for the situation presented on Table 7-1, no credit for control rod insertion is given if the rod control system is in manual.

Based on this, an ATWS CMP can be developed that is able to identify plant configurations that are acceptable or unacceptable with regard to maintaining defense-in-depth for ATWS events as plant configurations change with the time in the cycle. This will require licensees to have either cycle specific UETs or conservative UETs. Note that conservative UETs will overestimate the time of unfavorable exposure and may cause a plant to take unnecessary actions.

The ATWS CMP will have the following capabilities:

- Identify plant configurations (unfavorable configurations) that do not maintain defense-in-depth to an ATWS event.

- Track the time for individual occurrences when the plant is in an unfavorable plant configuration.
- Track the cumulative time per cycle when the plant is in an unfavorable plant configuration.
- Provide information on the length of time remaining in the UET for plant configurations.
- Provide compensatory actions to take if the unfavorable condition cannot be exited prior to expiration of the time allowed in the unfavorable configuration.

To maintain the proper level of control over the ATWS CMP and its use, it can be integrated into the Configuration Risk Management Program (CRMP) developed by utilities in response to the Maintenance Rule. The CRMP is typically contained within a plant's Technical Requirements Manual (TRM) or within plant procedures. The combined CRMP/ATWS CMP will be able to track the status of the ATWS mitigation systems and identify when the plant enters unfavorable configurations, and also track the cumulative time in these configurations.

Compensatory Actions

If a plant enters an unfavorable configuration, there are several compensatory actions that can be taken. Any one or a combination of these actions can be used to address the ATWS defense-in-depth concern. The proposed compensatory actions follow. Licensees can use those that provide the appropriate benefit.

1. Back-up Reactor Trip: Implement an alternate method to trip the reactor based on removing power to the control rod drive mechanisms (CRDMs). This requires an operator action, that can be taken from the control room in a short time, to interrupt power to the motor-generator sets (of the CRDMs) or interrupt power from the motor-generator sets (of the CRDMs) to the CRDMs. This would provide a backup reactor trip signal that is diverse from the reactor protection system (RPS). The only common components will be the sensors and isolators that provide input to the RPS and control board indication. This operator action will need to be listed early in the plant's emergency operating procedures and the operators will need to be trained on the action.

As an alternative to a back-up reactor trip from the control room, a utility may consider locating a dedicated operator at the MG sets if an unfavorable configuration exists beyond an acceptable time period. This would be beneficial for short durations, but may not be feasible for an extended time frame.

Once this compensatory action is implemented, further tracking of the time operating in an unfavorable configuration is not necessary.

2. UET Re-calculation: Re-calculation of UETs can be done based on plant specific information using analysis enhancements which may provide a better (shorter) estimate of the UETs. For example, if a plant is using a generic set of UETs for a representative plant that is similar in design, but not identical, it may be possible to complete plant specific analysis that will provide shorter UETs. In addition, depending on the end-of-cycle burn-up assumptions for the previous cycle, using the actual end-of-cycle burn-up may also provide a benefit.

3. Power Reduction: The plant power level can be reduced to a level where the plant configuration becomes favorable. With the lower power level, RCS pressures following an ATWS event can be mitigated with reduced pressure relief capability. The plant can then operate at this reduced power level until the configuration becomes favorable as the time into the cycle increases.

Time Allowed in an Unfavorable Configuration

A 30 day cumulative time limit in an unfavorable condition is proposed. In some cases this length of time will provide sufficient time for the plant to exit the unfavorable configuration as the cycle progresses. This time can also be used to implement appropriate compensatory actions. The 30 day limit is based on the following:

- For a 500 day fuel cycle, a 5% UET would equate to 25 days. This is based on the 5% UET requirement placed on the Braidwood and Byron core designs.
- The industry, along with the NRC, is currently developing a risk-informed Technical Specification directed at flexible allowed outage times (AOTs) with a 30 day backstop. In this activity, a maximum time of 30 days would be allowed to return Technical Specification equipment to operable status if the risk analysis supports it.
- The risk associated with blocking a PORV is low. Following the approach in Regulatory Guide 1.177 for setting Technical Specification AOTs, a time of over 3000 hours can be justified via the risk analysis for blocking a PORV (see Section 5.1.7 and 5.2.2 of the WCAP).

Note that this 30 day time period is cumulative.

Technical Clarification 1.b. The TR should clearly describe the methodology licensees would use to develop a plant- and cycle-specific ATWS configuration management program. Specifically, the TR should describe how the UETs would be calculated based on the plant- and cycle-specific parameters, such as core design and current cycle operating history (e.g., downpowers, shutdowns, etc.), and how these calculations will be controlled and verified prior to, during, and following plant startup.

Response: The response to Technical Clarification 5.d provides the requested information.

Technical Clarification 1.c. The plant-specific reload analysis for each cycle should ensure that the UET is minimized based on established criteria for specific conditions. For example, a 0 percent UET could be set as a core reload acceptance criteria based on the following assumed conditions:

i. Hot full power moderator temperature coefficient;
ii. Equilibrium xenon;
iii. Nominal hot full power inlet temperature;
iv. One minute of automatic control rod insertion (CRI) (i.e., 72 steps of insertion of the lead bank);
v. All power operated relief valves (PORVs) operable; and

vi. 100 percent auxiliary feedwater (AFW) flow available.

Response: The approach to maintain defense-in-depth, or ATWS pressure transient mitigation capability, is to operate the plant in a configuration with a zero UET. Using this approach, the reload analysis will need to ensure that at least one plant configuration, with regard to CRI, AFW, and PORV availability, will have a zero UET. It is agreed that the six conditions listed above are the appropriate core reload acceptance criteria. As a clarification to Condition iv, 72 steps of control rod insertion of the lead bank is the key part of this condition. Specification of one minute of automatic rod insertion is not necessary.

Technical Clarification 1.d. The configuration management program should be based on the effective full power days of operation at the plant.

Response: The WOG agrees that effective full power days of operation should be the basis for the ATWS CMP.

Technical Clarification 1.e. The configuration management program should be designed to prevent the voluntary entry into an UET. The performance of routine surveillances and routine maintenance or testing could be reasonably scheduled and performed either prior to or after time intervals where it would cause entry into an UET. The TR should establish the criteria or conditions governing voluntarily entry into an UET. This includes criteria such as the controls and limitations on these entries, when these voluntary entries will be allowed or not allowed, what compensatory actions will be implemented prior to and during any planned voluntary entries, how long specific voluntary entries will be allowed, and what if any compensatory actions may be taken to allow an extension of the voluntary entry.

Response: Entries into unfavorable configurations to meet Technical Specification surveillance requirements and repair inoperable equipment are acceptable. Entries into unfavorable configurations to complete preventive or routine maintenance activities should be minimized. Some of the equipment important to mitigation of an ATWS pressure transient is also important to mitigation of design basis events. These design basis events typically are larger contributors to plant risk than the ATWS event, therefore, it is important to maintain the equipment operability for design basis event mitigation. The surveillance requirements demonstrate component operability, therefore, it is recommended that they continue to be completed at the specified interval. Similarly, inoperable components should be repaired to maintain design basis event mitigation capability.

If component inoperability, due to surveillance requirements, maintenance activities, or repair activities, moves the plant into an unfavorable configuration, then simultaneous test and maintenance activities that compromise the availability of the reactor protection system (reactor trip signals, in particular) or that place the plant in a higher trip potential configuration should be rescheduled when the plant returns to a favorable configuration.

The time a plant may enter an unfavorable configuration to meet a surveillance requirement is relatively small, as demonstrated in the following. The systems/components of interest are:

- Auxiliary feedwater
- Pressurizer PORVs
- Pressurizer PORV block valves
- Pressurizer safety valves
- Rod control system
- AMSAC
- Turbine trip (steam stop valves and steam control valves)

The surveillance requirements identified in the Technical Specifications (NUREG-1431) for these systems/components along with surveillances required by plant procedures, from a generic perspective, are summarized on Table 1. Similar information is provided on Table 2 for Braidwood including the times the surveillance requirements cause the system/component to be inoperable. It is concluded from this that the time these systems/components are unavailable to meet surveillance requirements is small in comparison to the (proposed) 30 day total time allowed in an unfavorable configuration. Therefore, it is proposed that this time does not need to be tracked against the total time allowed in unfavorable configurations, if it does place the plant in an unfavorable configuration.

Technical Clarification 1.f. Entry into an UET should be permitted for performance of actions necessary to startup the plant and ensure proper operability and testing of equipment (e.g., manual rod control during startup to enable rod operability testing, etc.) However, these actions should be scheduled and controlled to prevent excessive entry into UET conditions.

Response: Startup testing is necessary to ensure equipment is operable to meet design basis event mitigation assumptions. There are no plans to modify startup testing or the startup process based on ATWS concerns. The applicable UETs during a startup are those without equilibrium xenon and the configuration is unfavorable at the beginning of the cycle for all configurations for the low, high, and bounding reactivity cores (see Tables 4-5, 4-6, 4-9, 4-10, 4-13, and 4-14 of the WCAP). Therefore, at the beginning of the cycle and without equilibrium xenon, delaying removal of equipment from service based on ATWS considerations provides no benefit. But general good practices will be followed to maintain ATWS prevention and mitigation capabilities during startup.

Technical Clarification 1.g. With the understanding that unforeseen circumstances may arise, the configuration management program should limit the time UET conditions are permitted to persist for events beyond the control of the licensee (i.e., equipment failure, emergency actions, etc.). Procedures should be developed and actions should be identified such that the plant will exit an UET condition in a timely fashion. A list of proposed actions and procedures should be developed and described in the TR to ensure that time spent in an UET condition by a licensee is limited. For example, controls similar to technical specification limiting conditions of operation, action statements, and surveillance requirements (SRs) should be clearly identified to allow proper monitoring of UET conditions and minimize operations under UET conditions. Additionally, the staff requests that these compensatory actions be clearly described and supported by technical justifications which ensure that UETs are minimized.

Response: The response to Technical Clarification 1.a provides high level guidance on the time limit a plant will be allowed to operate in unfavorable configurations and also the compensatory actions to be taken if a plant exceeds this time limit. Controls (procedures and actions) following this high level guidance will be developed on a plant specific basis and included in the appropriate plant document(s). This level of detail will not be added to the WCAP. In addition, there are no plans to develop additional limiting conditions of operation, action statements, or surveillance requirements for inclusion in Technical Specifications.

Technical Clarification 1.h. The configuration management program needs to consider not just maintenance-related activities, which seems to be the only focus under the current approach, but also any time ATWS-related components/systems are out of service, unavailable, or not in their expected state/condition (e.g., testing, discovery of inoperable or failed conditions) such that they are unable to perform their functional response to an ATWS event.

Response: The WOG agrees with the NRC's comment. It is not the intent of the ATWS CMP to consider only maintenance-related activities, but all activities (testing, preventive maintenance, and repair) that cause the systems important to ATWS mitigation to be unavailable.

Technical Clarification 1.i. The TR should explicitly address how plants will respond to conditions in which the ATWS-related equipment is unavailable, as identified above. The staff does not accept the concept that there are no situations that may require changing operation to a plant mode where ATWS events are no longer applicable, such as moving to Mode 3. There should be administrative requirements to proactively respond to these conditions to minimize and/or eliminate the UET, which may include actions to lower power, shutdown, extend an outage, or terminate start-up, as appropriate.

Response: As discussed in the response to Technical Clarification 1.a, the WCAP will provide the high level guidance that licensees will use to develop detailed plant specific guidance. A plant will identify compensatory actions to take when the cumulative time allowed in unfavorable conditions is exceeded. These actions include one or more of the following:

- Implement a back-up reactor trip actuated by operator action
- Perform UET re-calculations
- Initiate a power reduction

The plant power level can be reduced to a level where the plant configuration becomes favorable. With the lower power level, RCS pressures following an ATWS event can be mitigated with reduced pressure relief capability. The plant can then operate at this reduced power level until the configuration becomes favorable as the time into the cycle increases. The response to Technical Clarification 7 provides additional information regarding UETs for lower power levels.

Plant startups will be done consistent with current plant procedures and Technical Specifications. If a plant starts up with equipment inoperable, such that the configuration is unfavorable, startup can continue consistent with plant procedures and Technical Specifications, and the time in the unfavorable configuration will be accumulated against the total time allowed in an unfavorable configuration.

Plant shutdown is not an acceptable alternative. From a risk perspective, the risk level associated with a plant shutdown and the following startup, although small, is not zero and comparable to the ATWS risk from continued at-power plant operation.

Technical Clarification 1.j. The SRs that will be implemented in support of the ATWS configuration management approach should be identified and justified as acceptable in periodically assuring that ATWS-related equipment is available and functional, consistent with the cycle-specific ATWS configuration management approach matrix.

Response: No additional surveillance requirements will be required to demonstrate operability of the equipment monitored with the ATWS CMP that is required to maintain ATWS defense-in-depth capability. The equipment of interest and the current surveillance requirements are:

- Auxiliary feedwater: Technical Specification (TS) Surveillance Requirements 3.7.5.1, 3.7.5.2, 3.7.5.3, 3.7.5.4, and 3.7.5.5
- Pressurizer PORVs: TS Surveillance Requirements 3.4.11.2, 3.4.11.3, and 3.4.11.4
- Pressurizer PORV block valves: TS Surveillance Requirements 3.4.11.1, and 3.4.11.4
- Pressurizer safety valves: TS Surveillance Requirements SR 3.4.10.1
- Rod control system: TS Surveillance Requirement 3.1.4.2 and Plant Procedures
- AMSAC: Plant Procedures
- Turbine trip (steam stop valves and steam control valves): Plant Procedures

Note: The Technical Specification (TS) requirements are based on the Standard Technical Specifications, Westinghouse Plants, NUREG-1431, Vol. 1, Rev. 2, April 2001.

Technical Clarification 1.k. A detailed description of the training, tools, and procedures supplied to operators to permit them to assess the significance of plant operating conditions should be provided including time-in-life, equipment availability, and current cycle operating history (e.g., down-powers, shutdowns). From this description it should be clear that operators will have the necessary training and understanding to ensure that entry into UETs is to be minimized and that the prompt return to a non-UET condition is essential.

Response: Appropriate training will be provided to operators to ensure the ATWS CMP and associated compensatory actions are implemented correctly. This will include training in the following areas:

- Unfavorable exposure times as related to acceptable plant configurations and time in the cycle
- Equipment important to mitigating ATWS events
- Equipment important to preventing ATWS events
- Tracking UETs with effective full power days of operation
- Time allowed in unfavorable plant configurations and compensatory actions

A detailed description of the training, tools, and procedures that will be provided to operators will be developed on a plant specific basis following high level requirements specified in the WCAP.

Table 1
General Assessment: Summary of Surveillance Requirements for Systems Important to Mitigation of the ATWS Pressure Transient

System	Surveillance Requirement Number[1]	Surveillance Requirement and Frequency	Component Availability to Respond to an ATWS Event during Performance of Surveillance
Pressurizer Safety Valves	Tech Spec SR 3.4.10.1	SR: Verify each pressurizer safety valve is OPERABLE in accordance with the Inservice Testing Program. Following testing, lift settings shall be within ±1%. Frequency: In accordance with the Inservice Testing Program	This surveillance is performed with the plant shutdown, therefore, the safety valves will be available at power.
Pressurizer PORVs	Tech Spec SR 3.4.11.1	T.S. Notes: 1. Not required to be performed with block valve closed in accordance with the Required Actions of this LCO. 2. Only required to be performed in MODES 1 and 2. SR: Perform a complete cycle of each block valve. Frequency: 92 days	The block valve will be closed for only a short time period since it is only required to be cycled. The PORVs will not be available during this surveillance.
	Tech Spec SR 3.4.11.2	T.S. Note: Only required to be performed in MODES 1 and 2 SR: Perform a complete cycle of each PORV. Frequency: [18] months	The block valve will be closed for this surveillance. The PORVs will not be available during this surveillance.
	Tech Spec SR 3.4.11.3	SR: [Perform a complete cycle of each solenoid air control valve and check valve on the air accumulators in PORV control systems. Frequency: [18] months]	The PORVs will not be available during this surveillance if done at power.
	Tech Spec SR 3.4.11.4	SR: [Verify PORVs and block valves are capable of being powered from emergency power sources. Frequency: [18] months]	PORVs and block valves will be available during this surveillance.
AFW	Tech Spec SR 3.7.5.1	T.S. Note: [AFW train(s) may be considered OPERABLE during alignment and operation for steam generator level control, if it is capable of being manually realigned to the AFW mode of operation.] SR: Verify each AFW manual, power operated, and automatic valve in each water flow path, [and in both steam supply flow paths to the steam turbine driven pump,] that is not locked, sealed, or otherwise secured in position, is in the correct position. Frequency: 31 days	AFW will be available during this surveillance.
	Tech Spec	T.S. Note: [Not required to be performed for the turbine driven AFW	These surveillances are performed on

	SR 3.7.5.2	pump until [24 hours] after ≥ [1000] psig in the steam generator.] <u>SR:</u> Verify the developed head of each AFW pump at the flow test point is greater than or equal to the required developed head. <u>Frequency:</u> In accordance with the Inservice Testing Program.	recirculation flow. AFW will not be available during this surveillance unless AFW start signals re-align valves for flow to the SGs.
	Tech Spec SR 3.7.5.3	<u>T.S. Note:</u> [AFW train(s) may be considered OPERABLE during alignment and operation for steam generator level control, if it is capable of being manually realigned to the AFW mode of operation.] <u>SR:</u> Verify each AFW automatic valve that is not locked, sealed, or otherwise secured in position, actuates to the correct position on an actual or simulated actuation signal. <u>Frequency:</u> [18] months	This surveillance actuates components to their required position for AFW flow. AFW will be available during this surveillance.
	Tech Spec SR 3.7.5.4	<u>T.S. Notes:</u> 1. [Not required to be performed for the turbine driven AFW pump until [24 hours] after ≥ [1000] psig in the steam generator.] 2. [AFW trains(s) may be considered OPERABLE during alignment and operation for steam generator level control, if it is capable of being manually realigned to the AFW mode of operation.] <u>SR:</u> Verify each AFW pump starts automatically on an actual or simulated actuation signal. <u>Frequency:</u> [18] months	If this surveillance is performed with the plant shut down, AFW will be available at power. If done at power, valves may re-align on AFW start signal.
	Tech Spec SR 3.7.5.5	<u>SR:</u> [Verify proper alignment of the required AFW flow paths by verifying flow from the condensate storage tank to each steam generator. <u>Frequency:</u> Prior to entering MODE 2 whenever unit has been in MODE 5, MODE 6, or defueled for a cumulative period of > 30 days]	This surveillance is performed prior to the plant entering Mode 2, therefore, AFW will be available at power.
Steam Stop & Control Valves	Plant Procedures	<u>SR:</u> Cycle the valves closed. <u>Frequency:</u> Based on turbine overspeed protection requirements.	The valves are cycled to the closed position which is the required position for tripping the turbine, therefore, valves will be available at power.
Rod Control System	Tech Spec 3.1.4.2	<u>SR:</u> Verify rod freedom of movement (trippability) by moving each rod not fully inserted in the core ≥ 10 steps in either direction. <u>Frequency:</u> 92 days	Rod control system placed in manual during this surveillance, therefore, automatic rod control will not be available at power.
	Plant Procedures	<u>SR:</u> Axial flux difference calibration <u>Frequency:</u> Utility dependent	Rod control system placed in manual during this surveillance, therefore, automatic rod control will not be available at power.

	Plant Procedures	SR: Turbine governor valve testing Frequency: Plant specific	Rod control system placed in manual during this surveillance, therefore, automatic rod control will not be available at power.
AMSAC	Plant Procedures	SR: AMSAC testing Frequency: Plant specific	AMSAC will not be available during this surveillance.

Notes:
1. Based on Standard Technical Specifications, Westinghouse Plants, NUREG-1431, Vol. 1, Rev. 2, April 2001.

Table 2
Braidwood Specific: Summary of Surveillance Requirements for Systems Important to Mitigation of the ATWS Pressure Transient

System	Surveillance Requirement Number[1]	Surveillance Requirement and Frequency	Time Component is Unavailable to Perform Surveillance
Pressurizer Safety Valves	Tech Spec SR 3.4.10.1	SR: Verify each pressurizer safety valve is OPERABLE in accordance with the Inservice Testing Program. Following testing, lift settings shall be within ±1%. Frequency: In accordance with the Inservice Testing Program	0 hours; This surveillance is performed with the plant shutdown, therefore, the safety valves will be available .
Pressurizer PORVs	Tech Spec SR 3.4.11.1	T.S. Notes: Not required to be met with block valve closed in accordance with the Required Action of Condition B or E. SR: Perform a complete cycle of each block valve. Frequency: 92 days	0.1 hours; The block valve will be closed for only a short time period since it is only required to be cycled. The PORVs will not be available during this surveillance.
	Tech Spec SR 3.4.11.2	T.S. Note: Only required to be performed in MODES 1 and 2 SR: Perform a complete cycle of each PORV. Frequency: 18 months	0.1 hours; The block valve will be closed during this surveillance. The PORVs will not be available during this surveillance.
	Tech Spec SR 3.4.11.3	SR: Perform a complete cycle of each solenoid air control valve and check valve on the air accumulators in PORV control systems. Frequency: 18 months	0 hours; Surveillance is performed with the plant shutdown, therefore, the PORVs will be available .
AFW	Tech Spec SR 3.7.5.1	SR: Verify each AFW manual, power operated, and automatic valve in each water flow path that is not locked, sealed, or otherwise secured in position, is in the correct position. Frequency: 31 days	0 hours; AFW will be available during this surveillance.
	Tech Spec SR 3.7.5.2	SR: Verify day tank contains ≥ 420 gal of fuel oil. Frequency: 31 days	0 hours; AFW will be available during this surveillance.
	Tech Spec SR 3.7.5.3	SR: Operate the diesel-driven AFW pump for ≥ 15 minutes. Frequency: 31 days	0 hours; AFW will be available during this surveillance.
	Tech Spec SR 3.7.5.4	SR: Verify the developed head of each AFW pump at the flow test point is greater than or equal to the required developed head. Frequency: In accordance with the Inservice Testing Program.	0 hours; AFW will be available during this surveillance.
	Tech Spec SR 3.7.5.5	SR: Verify each AFW automatic valve that is not locked, sealed, or otherwise secured in position, actuates to the correct position on an actual or simulated actuation signal.	0 hours; This surveillance actuates components to their required position for AFW flow. AFW will be

		Frequency: 18 months	available during this surveillance.
	Tech Spec SR 3.7.5.6	SR: Verify each AFW pump starts automatically on an actual or simulated actuation signal. Frequency: 18 months	0 hours; Valves closed during this surveillance automatically open on actual AFW/AMSAC actuation signal. AFW will be available.
	Tech Spec SR 3.7.5.7	SR: Verify proper alignment of the required AFW flow paths by verifying flow from the condensate storage tank to each steam generator. Frequency: Prior to entering MODE 2 whenever unit has been in MODE 5, MODE 6, or defueled for a cumulative period of > 30 days]	0 hours; This surveillance is performed prior to the plant entering Mode 2, therefore, AFW will be available at power.
	Tech Spec SR 3.7.5.8	SR: Verify fuel oil properties are tested in accordance with, and maintained within the limits of, the Diesel Fuel Oil Testing Program Frequency: In accordance with the Diesel Fuel Oil Testing Program	0 hours; AFW components remain available during this surveillance.
Steam Stop & Control Valves	Plant Procedures	SR: Cycle the valves closed. Frequency: Based on turbine overspeed protection requirements	0 hours; The valves are cycled to the closed position which is the required position to trip the turbine, therefore, valves are available at- power.
Rod Control System	Tech Spec 3.1.4.2	SR: Verify rod freedom of movement (trippability) by moving each rod not fully inserted in the core ≥ 10 steps in either direction. Frequency: 92 days	1 hour; Rod control system placed in manual during this surveillance, therefore, automatic rod control will not be available.
	Plant Procedures	SR: Axial flux difference calibration Frequency: 4 channels @ 92 days per channel	< 0.5 hour/channel; Rod control system placed in manual during this surveillance (only while the NI channel is being placed in or taken out of test). Therefore, automatic rod control will not be available.
	Plant Procedures	SR: Turbine governor valve testing Frequency: 92 days	1 hour; Rod control system placed in manual during this surveillance, therefore, automatic rod control will not be available.
AMSAC	Plant Procedures	SR: AMSAC testing Frequency: Semi-annual	4 hours; AMSAC will not be available during this surveillance.

Notes:

1. Based on Braidwood Unit 1 and Unit 2 Technical Specifications.

Technical Clarification 2. Since an ATWS is a beyond design basis accident, crediting the rod control system for limiting the peak pressures experienced may be acceptable to the staff. However, the rod control system is a control system that it is not assumed to mitigate the consequences of Chapter 15 design basis transients and accidents. Therefore, the TR should contain sufficient information to provide the staff with a reasonable assurance that the rod control system will function as assumed in WCAP-15831-P. Additionally, with regard to the assumptions used in Item 1c to determine the plant- and cycle-specific UET, the 72-step automatic CRI credit is contrary to the assumption of no CRI credit used in the basis for the ATWS rule. In order for the staff to find that this credit is acceptable, the WOG should provide technical analyses demonstrating that the rod control system will be capable of performing the required mitigative safety function under core conditions representative of an ATWS, i.e., high temperatures and pressures.

Response: The WOG model credits 72 steps, in some sequences, from the lead control rod bank in response to an ATWS event. In response to the increase in RCS temperature, as measured by the resistance temperature detectors (RTDs), the rod control system will begin stepping the control rods into the core. The only components of the rod control system that will be exposed to the high temperature RCS environment are the RTDs. The RTDs provide the T_{avg} that is used in conjunction with the T_{ref} to control rod movement. The T-hot and T-cold RCS measurements are used to calculate the T_{avg} signal in the process equipment. The signal to the rod control system will saturate at about 630°F and then continue to provide a constant signal. The T_{avg}/T_{ref} temperature difference will continue to be great enough for the rod control system to continue to move the rods in at 72 steps per minute.

This type of response has been verified for the 7300 and Eagle-21 process protection systems.

<u>**Technical Clarification 3.**</u> In Section 8.2.4, it is stated that "[r]egardless of whether this action succeeds or fails, the ATWS event can be mitigated depending on the availability of AFW and RCS pressure relief." This statement and resulting logic modeling does not appear to address the conditions for some fuel designs (e.g., bounding reactivity) in which the UET exists even with all equipment available with the exception that the rod control system is in manual (cf. Table 4-36). By definition, for the fuel designs that create an UET even with all equipment available and the rod control system in manual, a success state cannot be achieved if top events reactor trip (RT), operator action to M-G set (OAMG), and CRI all fail (or if top event [control rod] CR is failed by itself). The text and ATWS event tree logic models should be revised to address these potential fuel design-specific conditions. Also, identify if there are any other situations in which the ATWS event tree logic is not consistent with any of the analyses presented in Chapter 4 and the resulting ATWS configuration management approach.

Response: It is agreed that if CRI fails (automatic or manual action to drive in the control rods), then successful ATWS event mitigation may not be possible, depending on the particular core design, time in the cycle, and AFW and pressure relief availability. In the extreme case for a core design has non zero UETs for all twelve plant configurations (for the various combinations of control rod insertion, AFW flow, and PORV availability), then the ATWS pressure transient cannot be mitigated for some part of the cycle regardless of the plant configuration. As the event tree is currently constructed, the top event PR (primary pressure relief) accounts for this possibility. Similarly for a core design that has non zero UETs for all plant configurations except the single condition with CRI success (72 steps of control insertion), 100% AFW flow, and no PORVs blocked. If CRI fails, then the ATWS pressure transient cannot be mitigated. But again, the top event PR accounts for this possibility.

The words in Section 8.2.4, and also Section 5.1.1.5, will be changed to state that with some core designs CRI success is necessary during parts of the cycle to achieve successful pressure mitigation. It will also be noted that it is possible to design a core that for part of the cycle the ATWS pressure transient cannot be mitigated regardless of the success or failure of CRI. No changes to the event tree logic are required since the top event PR accounts for the UETs and ATWS pressure mitigation equipment availability.

Technical Clarification 4. With regard to Sections 4.1 through 4.5 of WCAP-15831-P, the WOG should provide a listing of key assumptions and plant conditions used in performing the deterministic analyses. Specifically, a table should be provided that contains the same parameters as those listed in Tables 3.1 and 3.2 of NS-TMA-282, "ATWS Submittal," dated December 30, 1979. To provide a good comparison of the data, this table should consist of columns containing the parameter information for the following cases: (1) the bounding reactivity model described in WCAP-15831-P, and (2) the most limiting WOG 4-loop, 3-loop, or 2-loop plant intended to be covered by WCAP-15831-P. For Case 2, the TR should justify why the particular plant chosen is the most limiting. Additionally, for each parameter in Case 2 which is not bounded by the value used in Case 1, a justification should be provided for the difference that demonstrates that the results obtained in WCAP-15831-P are bounding for this plant.

Response: The WCAP analyses are not meant to be bounding analyses that eliminates the need for plant specific evaluations. The WCAP analyses examined a wide range of core designs to demonstrate that even with a core design with the maximum part-power positive MTC Technical Specification limit licensed for Westinghouse plants, that the ATWS risk is very small. In addition, this showed that the risk impact of moving to such a core, from a core that meets a 5% UET for the reference conditions (no rod insertion, 100% AFW, no PORVs blocked) is also very small.

The term "bounding core" was used to denote a core designed to the Technical Specification limits. This was not meant to infer that the deterministic and risk analyses with the bounding core enveloped all W NSSS plants and no additional plant specific work is required. The reload implementation process, described in Section 10 of the WCAP, requires that licensees use plant specific or bounding UETs. The WOG will decide on the appropriate approach. If bounding UETs are used, then a number of UET sets will be developed and the various plants will be binned into the various UET groups. At that point, if bounding UETs are used, the WOG will develop the justification for the plant binning process.

At this point, the requested information is not provided since the results in the WCAP are not meant to be bounding in the sense that plant specific analysis is no longer required. Since plant specific analysis is still required, the values used in the plant specific work will be justified, not the values used in the "bounding" reactivity core analysis.

Technical Clarification 5. Regarding the calculation of critical power trajectory (CPT) and UETs, the staff requests the following information:

Technical Clarification 5.a. The CPTs were calculated for the two pressure-limiting ATWS events based on the 1979 generic Westinghouse ATWS analyses (i.e., Westinghouse letter NS-TMA-2182). The two events result in the complete loss of all main feedwater without a reactor trip and are identified as the loss-of-normal feedwater ATWS and the loss-of-load ATWS. A description of the evaluation performed should be provided to demonstrate that these events remain the limiting ATWS events for current core designs and operations.

Response: The Loss of Normal Feedwater and Loss of Load events are limiting because they result in the largest heat source/heat sink mismatch. Current core designs and operations, such as upratings, only make these events more limiting since the loss or degradation of the secondary heat sink increases the mismatch and results in a larger heat source with no corresponding heat sink.

The following provides a qualitative review of the other ATWS events and why they are not more limiting than the Loss of Normal Feedwater and Loss of Load events. The following events are discussed:

- Rod Withdrawal at Power
- Rod Withdrawal from Subcritical
- Partial Loss of Flow
- Accidental RCS Depressurization
- Excessive Load Increase
- Loss of AC Power
- Feedwater Malfunction
- Boron Dilution
- Startup of an Inactive Loop
- Dropped Rod

The Rod Withdrawal at Power (RWAP) event results in a pressurization of the RCS, but this pressure increase is limited by the rod worth and the total reactivity that can be inserted until the rods are fully withdrawn. The secondary heat sink is also intact and available for heat removal. Following withdrawal of the rods, nuclear feedback causes core power to decrease to the secondary side load. The plant will reach an equilibrium condition at an elevated Tavg. The results will therefore be less limiting than both the Loss of Load and Loss of Normal Feedwater events.

The Rod Withdrawal from Subcritical event is similar to the Rod Withdrawal at Power event. The limited amount of reactivity that can be inserted, plus the availability of the secondary heat sink, make this event less severe than the Loss of Normal Feedwater and Loss of Load events.

The Partial Loss of Flow event results in a primary side heatup and pressure increase. However, the loss of coolant flow would result in voids in the core and an associated reduction in reactivity and core power. Since the secondary side is intact, substantial heat removal can be maintained. The results of this event will therefore be less limiting than those of the Loss of Normal Feedwater and Loss of Load events.

The Accidental RCS Depressurization event results in a decrease in primary side pressure, and is therefore less limiting than the Loss of Normal Feedwater and Loss of Load events.

The Excessive Load increase event results in an increase in core power. However, due to the primary side cooldown resulting from the increase in steam flow, the RCS pressure decreases during the event. Therefore, this event is also less limiting than the Loss of Normal Feedwater and Loss of Load events.

The Loss of AC Power event yields results that will be less limiting than those from the Loss of Normal Feedwater event. During a Loss of AC Power event, the RCP coastdown will dominate the beginning of the transient causing an increase in core fluid temperature, which subsequently causes the core power to decrease. The core power will be lower in the Loss of AC Power event than in the Loss of Normal Feedwater event when steam generator inventory decreases to the point at which steam generator heat transfer is degraded. Therefore, the results of the Loss of AC Power event will be less severe than the Loss of Normal Feedwater.

The Feedwater Malfunction event results in an excessive increase in heat removal and an increase in core power due to a cooldown in the primary side. Although the core power increases, the cooldown yields a decrease in the RCS pressure. This event is therefore less limiting than either the Loss of Normal Feedwater or the Loss of Load events.

The Boron Dilution event is similar to the RWAP event. The dilution causes an increase in reactivity, which increases core power and results in a pressurization of the RCS. The increase in core power and pressure is much slower in the boron dilution event than the RWAP event. As in the RWAP event, the power increase is eventually offset by reactivity feedback. Since the secondary heat sink is intact, the plant can reach a new equilibrium condition. Based on this, this event is also less limiting than either the Loss of Normal Feedwater or Loss of Load events.

The Startup of an Inactive Loop event occurs when the cooler water in an inactive loop is inadvertently mixed with the remaining RCS inventory. This results in a cooldown of the RCS, and an increase in core reactivity and power. Since this is a cooldown event, there is only a small increase in RCS pressure due to the power increase. Any pressure increase that does occur is much less limiting than those in the Loss of Normal Feedwater and Loss of Load events.

In the Dropped Rod event, the response of the automatic rod control system to a dropped rod or bank of rods results in a power overshoot, and potential increase in RCS pressure. The plant reaches a new equilibrium condition after the overshoot. A reactor trip is not normally credited in the generic Westinghouse methodology for this event as described in WCAP-11394-P-A. The

RCS pressure does not approach 3200 psig for this event, and is less limiting than either the Loss of Normal Feedwater or Loss of Load event.

Based on the above discussions, the Loss of Normal Feedwater and Loss of Load events are the limiting ATWS events.

Technical Clarification 5.b. The CPT calculations are described in Section 4.1 of the TR and are based on a nuclear steam supply system (NSSS) power level of 3579 MWt. Since some plants are either currently licensed to or pursuing uprates for power levels greater than 3579 MWt, please discuss how power levels in excess of 3579 MWt can be accounted for in the CPT and UET calculations described in WCAP-15831-P to extend the validity of the TR as power levels increase. The staff also requests the WOG to provide a list of resulting limitations and conditions for the use of the TR (e.g., power levels, peaking factors, steam generator type).

Response: The CPT and UET calculations presented in the topical report represent an example of the process that will be used on a plant specific basis. These example calculations are not intended to bound all plant configurations. The CPTs and UETs will be justified when this process is implemented for a given plant. The particular plant's power level, peaking factors, and steam generator type will be appropriately accounted for at that time.

Technical Clarification 5.c. The CPTs are calculated using the LOFTRAN computer code and the UETs are calculated using the ANC computer code. Please demonstrate that all restrictions and limitations are satisfied for the present application of these codes.

Response: The LOFTRAN code remains valid for this application. The calculation of the CPTs does not exercise the code in any radically different way from its current and past applications, including its use in the NS-TMA-2182 ATWS study. The Safety Evaluation Report (SER) on LOFTRAN, as found in WCAP-7907-P-A, specifically calls out the use of the code for ATWS.

The qualification of the PHOENIX-P/ANC nuclear design system is documented in WCAP-11596-P-A (T. Q. Nguyen, et al., "Qualification of the PHOENIX-P/ANC Nuclear Design System for Pressurized Water Reactor Cores," June 1988). PHOENIX-P is the cross section lattice code, and ANC is the 3D nodal core simulator. WCAP-11596 qualified PHOENIX-P/ANC for the multi-dimensional nuclear analysis of PWR cores. This WCAP, including the SER, indicates no specific limitations or restrictions on the use of ANC. With respect to the qualification of ANC, the SER stated the following: "...these comparisons cover the areas expected to be studied for a nodal code system to be used for PWR analyses, and they provide a wide range of relevant parameters and variations to test the capabilities of the system. The selected reactors were suitably representative and reasonably diverse, and provided sufficient approach to extremes of expected operating parameters."

The ANC calculations performed to calculate ATWS UETs involve calculations of critical powers at the peak pressure limit over a range of inlet temperatures (600 °F to 660 °F) and burnups. These critical power search calculations are similar to other design basis calculations, e.g., steamline break calculations, which are routinely performed for each reload design. The critical powers that are calculated for the UET analysis are all within the range of 0% to 100%

power. The range of core average moderator densities encountered is approximately 0.59 g/cm^3 to 0.70 g/cm3. Because of the high pressure employed in these calculations, coolant voiding does not occur. Consequently, the moderator feedback effects are within the code's capabilities and are adequately modeled.

<u>Technical Clarification 5.d.</u> The CPT results are presented in Tables 4-1 and 4-2, but the TR does not provide a clear description of how these values are generated. For at least one representative point in the tables, please provide a detailed explanation of the methodology used to generate the CPT value. This should include the LOFTRAN generated plots for the key system parameter values used in the evaluation of CPT and a sample calculation demonstrating the method used to calculate the UETs provided in Section 4.2 of the TR. The explanation should include a detailed description of the ANC computer code model (e.g., noding, full core) and provide output plots for the key parameters generated by ANC. The WOG should also demonstrate how the ANC output is compared to the CPTs to determine UETs.

Response: The generation of the CPTs for the Loss of Load (LOL) event, at Tin values from 600°F to 660°F, full AFW capacity, with 2 PORVs/3 of 3 PSVs in operation is described below. These are the CPT values of 0.734, 0.561, 0.360, and 0.120 from Table 4-2 of the WCAP.

Calculation of the CPTs is a two step process. The first step is to run the LOFTRAN code to determine the reactivity feedback conditions that result in a peak RCS pressure of approximately 3200 psig. This is completed for each PORV/PSV and AFW flow assumption set. For this case, the assumptions are a LOL event with full AFW capacity, and 2 PORVs/3 of 3 PSVs in operation. The transient is analyzed from full power conditions. Reactivity coefficients, primarily MTC, are adjusted iteratively until the peak RCS pressure in the transient is approximately 3200 psig. The final reactivity coefficients are the only output used in the next step of the CPT calculation. For this case, the final MTC is approximately -6 pcm/°F.

In the second part of the analysis, the reactivity feedback conditions calculated in step #1 are used as a fixed boundary condition in the CPT calculations. In this calculation, it is assumed that the reactor is just critical at the defined values of core inlet temperature and core pressure (from LOFTRAN calculation in step #1). An iterative search on reactor power is completed for each subsequent pair of inlet temperature and pressure. The pairs for this case are 600°F/3200 psig, 620°F/3200 psig, 640°F/3200 psig, and 660°F/3200 psig. The reactivity calculation is performed using the same methods that are used in the LOFTRAN code. For each new temperature and pressure pair, an iterative search on reactor power is completed to find the critical condition (zero excess reactivity). It was found that core power fractions of 0.734, 0.561, 0.360, and 0.120 of nominal are calculated for the temperature/pressure pairs listed above, using the reactivity feedback from the step #1 LOFTRAN run.

The discussion below describes the ANC calculations used to determine the UET for the High Reactivity Core Model for ATWS Case 1 assuming equilibrium xenon and no control rod insertion. ATWS Case 1 assumes full auxiliary feedwater capability and all PORVs available. From Table 4-7 of WCAP-15831-P, the UET for this case was 110.1 EFPD.

ANC core models employ 2x2 nodes radially and, typically, 24 to 28 nodes axially to model an individual fuel assembly. The number of axial nodes may vary from plant to plant and cycle to cycle depending upon the details of the core design, e.g., the lengths of burnable absorbers, axial blankets, etc. Quarter-core symmetric models are typically used unless an asymmetry in the core loading pattern requires full core modeling. In the ATWS UET calculations, uniform inlet temperatures are assumed, so that use of quarter-core models is typical.

The ANC calculations to determine the UET are reasonably straightforward. For a given cycle burnup step, a precondition case is performed at nominal conditions (HFP, nominal temperature and pressure, equilibrium xenon). This case establishes the nominal critical boron concentration at this cycle burnup. The boron concentration and xenon distribution are held constant for the remaining calculations at this burnup step. Next a series of critical power calculations are performed at the peak pressure limit with various inlet temperatures (typically 600, 620, 640, and 660 °F). Thus, for each burnup step, four critical power values are obtained.

ANC does not provide output plots of key parameters for ATWS calculations. The key output parameter of interest is the converged critical power for each burnup step and inlet temperature. Table 3 below provides the results of these critical power calculations for this case. In Table 3, the ANC critical powers are given in terms of absolute megawatts and include the pump heat. For comparison, Table 3 also indicates the CPT values in terms of fraction of NSSS power and absolute megawatts. The 14 MWt values in the last column, over the burnup range 10000-22006 MWD/MTU, are not true critical powers. These values correspond to the pump heat. For these cycle burnups, the core power level calculated was 0 MW_t, indicating that the core was subcritical at the inlet temperature of 660 °F.

For each inlet temperature and burnup step, a parameter termed the "unfavorable power" is then calculated. This is simply the difference between the ANC critical power and the CPT power. These values are given in Table 4. Positive values indicate an unfavorable ATWS response since the ANC critical power is larger than the power level required to reach the peak pressure limit. Conversely, negative values indicate a favorable ATWS response since the ANC critical power is less than the power level required to reach the peak pressure limit. The values from Table 4 are plotted in Figure 1 (only values corresponding to burnups of up to 8000 MWD/MTU are plotted).

The UET is determined by the range of cycle burnups for which the unfavorable power is positive for any inlet temperature. As Figure 1 shows, the curve for 600 °F crosses the zero line at the largest burnup. This burnup is 4822 MWD/MTU, which corresponds to 110.1 EFPD. Since the UET starts at the beginning of the cycle (Figure 1 shows that BOL is unfavorable for all inlet temperatures), the total UET for this case is, therefore, 110.1 EFPD.

The other UET values in Table 4-7 of WCAP-15831-P were calculated in a similar fashion using CPT values appropriate for each case. Table 4-8 of the WCAP includes the effect of 72 steps of control rod insertion from the lead bank. The ANC calculations for this table are performed in the same fashion as described above, but the ANC critical power calculations include the negative reactivity effect of 72 steps of insertion of the lead control bank. This negative reactivity addition results in lower critical powers.

Implementation of this methodology for actual core designs will involve calculating the UETs for the ATWS cases in Tables 4-7 and 4-8 for the reload core (or confirming that previously employed UETs remain valid). These calculations will be performed using the same quality assurance procedures as are used for design basis analyses performed as part of the Reload Safety Evaluation. The ANC models used for the UET calculations will be the same models that are used for other reload core analyses. With these models, the UETs will be evaluated using best estimate global core reactivity and reactivity feedback predictions.

Variations in the operating cycle burnup can affect the next cycle's core reactivity, which in turn, could affect calculated UETs. These variations are addressed in the Reload Safety Evaluation process for the next cycle by generating separate ANC models based on low and high estimates of the current operating cycle's shutdown burnup (i.e., the operating cycle burnup window). The same process will be used for the ATWS UET calculations. If the operating cycle shutdown burnup is known, however, then UET calculations for the next cycle will be based on the actual operating cycle's burnup. This would be the case, for example, if the UET calculations are performed after the current cycle shuts down for refueling but before the next cycle operation begins. The UETs will be transmitted to the utility as part of the normal transfer of reload core operational and physics data. The utility will then prepare the configuration management program using the UET information. The UET data identifies which plant configurations are favorable and which are unfavorable for any cycle burnup. Since the UETs will be based upon cycle burnup or, equivalently, effective full power days (EFPD), the configuration management program will not be affected by shutdown periods or periods of part power operation.

<u>Technical Clarification 5.e.</u> Table 4-2 provides the loss of load ATWS CPTs. For no PORVs available and an inlet temperature (T_{in}) of 660°F, a dash is shown in the table (i.e., no value is given). Discuss the meaning of this dashed line and how a UET is calculated for this condition. What is the UET associated with these ATWS conditions?

Response: The dashed line indicates that the power level corresponding to an RCS pressure of 3200 psig and a Tin of 660°F, at the fixed reactivity conditions associated with the given case, is below zero. In other words, the reactivity feedback at that high temperature and pressure would shut the core down.

For cases in which the CPT is a "negative" power, the UET was conservatively calculated using an inlet temperature corresponding to a core power of zero (i.e., the point at which the CPT line intersects a power of zero).

<u>Technical Clarification 5.f.</u> Tables 4-1 and 4-2 of the TR provide CPT results for core inlet temperatures (T_{in}) ranging from 600°F to 660°F. Discuss the basis for the range of inlet temperatures (T_{in}) used. Does this temperature range bound all ATWS scenarios?

Response: A range of inlet temperatures between a typical full power, nominal Tin (~555°F) and a Tin of 660°F is assumed. The maximum value of 660°F has been found to yield critical powers close to zero. The reactivity feedback at an inlet temperature of 660°F and pressure of 3200 psig is sufficient to reduce the power to zero or near zero. The minimum value is chosen to be modestly elevated above the initial Tin (~555°F). Since the Tin value drives the pressure increase, the minimum Tin's must be high enough to result in peak pressures of 3200 psig.

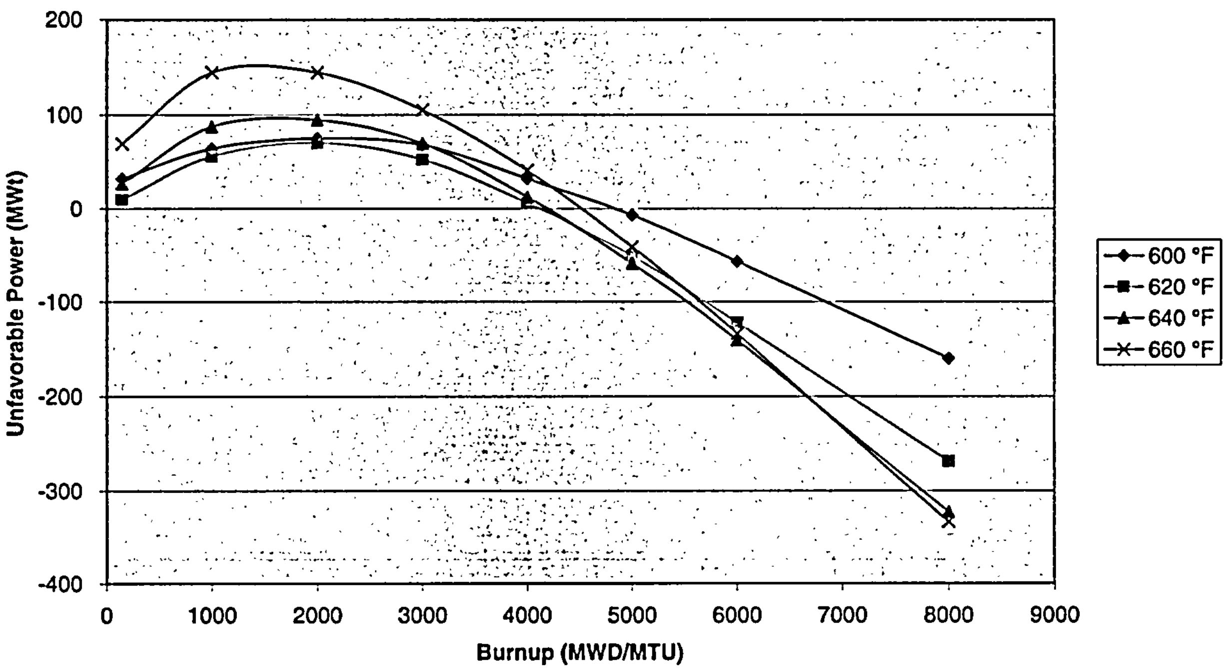
Table 3
ATWS Case 1 Critical Power Trajectory and ANC Critical Powers for the High Reactivity Core Model with Equilibrium Xenon and No Control Rod Insertion

Inlet Temperature (°F)		600	620	640	660
CPT Fraction of 3579 MW_t		0.734	0.561	0.360	0.120
CPT Power (MW_t)		2627	2008	1288	429
Cycle Burnup (MWD/MTU)	EFPD	ANC Critical Power (MW_t) for T_{in} of 600 °F	ANC Critical Power (MW_t) for T_{in} of 620 °F	ANC Critical Power (MW_t) for T_{in} of 640 °F	ANC Critical Power (MW_t) for T_{in} of 660 °F
150	3.4	2659	2018	1315	499
1000	22.8	2691	2064	1376	574
2000	45.7	2702	2078	1383	574
3000	68.5	2695	2060	1358	534
4000	91.3	2659	2014	1301	470
5000	114.1	2620	1957	1230	388
6000	137.0	2570	1886	1148	296
8000	182.6	2467	1739	966	96
10000	228.3	2370	1597	784	14
12000	273.9	2285	1465	624	14
14000	319.6	2210	1351	488	14
16000	365.3	2153	1258	381	14
18000	410.9	2096	1173	281	14
20000	456.6	2046	1098	189	14
22006	502.4	2010	1041	117	14

Table 4
ATWS Case 1 Unfavorable Power (ANC Power – CPT Power) for the High Reactivity Core Model with Equilibrium Xenon and No Control Rod Insertion

Cycle Burnup (MWD/MTU)	EFPD	Unfavorable Power (MWt) for T_{in} of 600 °F	Unfavorable Power (MWt) for T_{in} of 620 °F	Unfavorable Power (MWt) for T_{in} of 640 °F	Unfavorable Power (MWt) for T_{in} of 660 °F
150	3.4	32	10	27	69
1000	22.8	64	56	87	144
2000	45.7	75	70	95	144
3000	68.5	68	52	70	105
4000	91.3	32	6	13	41
5000	114.1	-7	-51	-59	-41
6000	137.0	-57	-122	-141	-134
8000	182.6	-160	-268	-323	-333
10000	228.3	-257	-411	-504	-415
12000	273.9	-342	-543	-665	-415
14000	319.6	-417	-657	-800	-415
16000	365.3	-474	-750	-907	-415
18000	410.9	-531	-835	-1007	-415
20000	456.6	-581	-910	-1100	-415
22006	502.4	-617	-967	-1171	-415

Figure 1
Unfavorable Power (MWt) for ATWS Case 1 of the High Reactivity Core Model as a Function of Cycle Burnup and Inlet Temperature



__Technical Clarification 6.__ For Approach 1 in Section 7, the TR states that the identified actions are proposed "... to restore defense-in-depth." While in an UET condition, four of the identified five actions restrict further activities that would not change the existing condition of being vulnerable to an ATWS event. Though these actions might prevent the plant condition from worsening, they do not consider the fact that the plant is already in an unacceptable configuration if an ATWS event occurs. Thus, these actions do not restore defense-in-depth, except for possibly the situations in which placing the rod control system in automatic could (if CRI is credited) eliminate the unfavorable configuration. The text should be revised to ensure unfavorable configurations are eliminated when they occur in accordance with the established controls supporting Item 1 above.

Response: Defense-in-depth against ATWS events is provided by prevention of the event and mitigation of the event if prevention fails. Prevention is provided by inserting the control rods into the core. This can be done automatically by the reactor protection system (RPS) or by an operator action to trip the plant. The reactor protection system provides the reactor trip signals (RTS). The typical RTS circuit consists or analog channels (field transmitters or process sensors and process control and protection system), combinational logic cabinets (solid state or relay protection system), and reactor trip switchgear (reactor trip breakers). The analog channels provide signals to each of the logic cabinets and are typically arranged in two of three or two of four logic to meet reliability requirements. The logic cabinets and reactor trip switchgear are arranged in two trains with either one capable of tripping the reactor. Therefore, there is a degree of defense-in-depth built into the RPS. In addition, an operator action to trip the reactor can be taken from the control room. This provides a backup to failures of analog channels and logic cabinets. The reactor trip breakers are required to open with this operator action. Therefore, this operator action provides an additional degree of defense-in-depth from the prevention perspective.

If an ATWS event does occur (prevention fails), then mitigation is provided by pressurizer safety valves and PORVs, along with AFW, for pressure relief and shutdown is provided by emergency boration.

The actions listed in Section 7 of the WCAP are:

- Restrict scheduled maintenance activities on the RPS
- Restrict scheduled maintenance activities on AMSAC
- Restrict scheduled maintenance activities on AFW
- Restrict blocking PORVs
- Place the rod control system in automatic control

The first action is directed at maintaining the defense-in-depth capabilities of the RPS and reducing the probability of the occurrences of an ATWS event. The next three actions will prevent further degradation of the configuration and will, in some cases, limit the RCS pressure to a level below which containment releases are a concern. Although these actions may not prevent core damage, they may prevent containment releases. The last action is directed at restoring defense-in-depth via pressure mitigation and then emergency boration. This will be clarified in the revision to this WCAP.

Technical Clarification 7. In Section 4.3.3 of WCAP-11992, it is stated that "... an initial power less than 70 percent will not result in RCS pressures greater than that corresponding to the ASME Level C service criterion ..." The staff interprets this statement as meaning that an UET is not possible at less than 70 percent power. Is this a correct interpretation and is this situation still valid for all current and expected plant cases and fuel designs (e.g., the bounding reactivity case)? If this situation is not valid for these conditions, please explain what has changed since the development (and recent efforts to get approval) of WCAP-11992 that make this statement not correct for WCAP-15831-P. If this situation is still valid, then the staff suggests that the mitigative strategies address how this power limitation could be used as a proactive response to potentially prolonged UETs, consistent with Item 1 above.

Response: WCAP-10858 Revision 1, the AMSAC Generic Design Package, states the following with respect to power "Short-term protection against high reactor coolant system pressures is not required until 70% of nominal power. However, in order to minimize the amount of reactor coolant system voiding during an ATWS, AMSAC should operate at and above 40% of nominal power. Furthermore, the potential exists for spurious AMSAC actuations during start-up at the lower power levels. To assure the above requirements are met, AMSAC will be automatically blocked at turbine loads less than 40% by the C-20 permissive." Thus, although the peak pressure limit may not be violated below 70% power, the AMSAC arming setpoint was conservatively established as 40% power.

The conclusion that the ASME Level C service criterion is met at power levels below 70% was based on the core configuration utilized in the ATWS analyses presented in NS-TMA-2182. As shown in Section 4.4, use of a high reactivity or bounding reactivity core model can yield non-zero UETs for some plant configurations even at a reduced power level. Reducing power will always reduce the UET, but will not eliminate it in all cases. Therefore, in some cases, reducing power would be a viable mitigative strategy. However, it would require additional analyses to determine the power reduction needed to eliminate the UET for all of the various core and plant configurations. These additional analyses would be similar to those completed for the full power cases. Iterative analyses would have to be completed to determine the power reduction required to eliminate the UET for the particular plant configuration. The analysis would include calculation of new CPTs at the reduced power level, followed by calculation of the UET for the plant and cycle specific core conditions following the same approach discussed in response to Technical Clarification 5.

EDITORIAL

Editorial Clarification 1. Throughout the TR, reference is made to an UET that is conditioned by a specific plant configuration (i.e., 100 percent PORV capacity available, 100 percent AFW system availability, no control rod insertion capability, and 100 percent ATWS mitigating system actuation circuitry (AMSAC) availability). Though this conditional definition was used in WCAP-11992 and was allowed as part of the current method of calculating and controlling the UET for some licensees, the staff does not believe this configuration condition is a valid aspect of the basic UET definition and can lead to misunderstandings. A more basic definition of UET would be the time in which the reactor core reactivity feedback is not sufficient to prevent RCS pressure from exceeding 3200 psig following an ATWS event. With this definition, the UET is defined by the plant's pressure response, which can change as the plant conditions and configurations change. Thus, for example, with all equipment operable a plant might not be in an UET condition, but if a specific ATWS-significant component becomes unavailable, the plant could then immediately enter a UET condition. This definition is then very similar to the definition of unfavorable moderator temperature coefficient (MTC) that is used in the supporting technical bases of the ATWS rule (10 CFR 50.62). To avoid confusion, whenever referring to the specific plant configuration consisting of 100 percent PORV capacity, 100 percent AFW system availability, no control rod insertion capability, and 100 percent AMSAC availability, it should be identified as the "ATWS rule reference case UET" or similar phrase that distinguishes this conditional definition from the more basic UET definition. It should also be recognized that this "ATWS rule reference case UET" may be a small portion of the actual UET experienced at a plant. Please revise WCAP-15831-P accordingly.

Response: The WOG definition of UET is provided in the second paragraph on Page 4-4 of the WCAP. The definition is given as "UET is defined as the time during the cycle when the reactivity feedback is not sufficient to prevent the RCS pressure from exceeding 3200 psig (the ASME Service Level C stress limit)." This is consistent with the definition proposed above by the NRC.

UETs are determined for the following plant configurations. All assume AMSAC and the pressurizer safety valves are available.

1. Control rod insertion (72 steps from lead bank), 100% AFW, 2 of 2 PORVs available
2. Control rod insertion (72 steps from lead bank), 50% AFW, 2 of 2 PORVs available
3. Control rod insertion (72 steps from lead bank), 100% AFW, 1 of 2 PORVs available
4. Control rod insertion (72 steps from lead bank), 50% AFW, 1 of 2 PORVs available
5. Control rod insertion (72 steps from lead bank), 100% AFW, 0 of 2 PORVs available
6. Control rod insertion (72 steps from lead bank), 50% AFW, 0 of 2 PORVs available
7. No control rod insertion, 100% AFW, 2 of 2 PORVs available
8. No control rod insertion, 50% AFW, 2 of 2 PORVs available
9. No control rod insertion, 100% AFW, 1 of 2 PORVs available
10. No control rod insertion, 50% AFW, 1 of 2 PORVs available
11. No control rod insertion, 100% AFW, 0 of 2 PORVs available
12. No control rod insertion, 50% AFW, 0 of 2 PORVs available

All twelve conditions are used in the ATWS risk model. Plant configuration 7 is used in the ATWS Rule. Where appropriate, this will be referred to as the "ATWS rule reference configuration".

<u>**Editorial Clarification 2.**</u> The TR includes the statement that SECY-83-293 demonstrates that the installation of AMSAC reduces the risk from ATWS events to an acceptable level. It should be noted that the SECY-83-293 supporting risk analysis and other related analyses performed in support of the ATWS rule were performed in the late 1970s and early 1980s based on plant operating conditions (i.e., plant equipment configurations and availability, fuel design, etc.) at that time. These analyses were performed well before the advent of the risk-informed decision-making processes within the NRC, such as described by Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," et. al. As such, the risk analyses developed in support of the ATWS rule were relatively simplistic and made some significant assumptions regarding plant operating conditions. Current plant operating conditions may be considerably different from those assumed in these analyses. Based on the above, it may be misunderstood to state that the SECY-83-293 analyses (performed almost two decades ago) demonstrates (present tense) an acceptable level of risk from ATWS events with the installation of AMSAC, when some of the most significant assumptions of those analyses may no longer be valid. Please revise WCAP-15831-P accordingly.

Response: Since this statement, in Section 2.1 of WCAP-15831-P, is taken directly from Section 2.1 of WCAP-11992 ("Joint Westinghouse Owners Group/Westinghouse Program: ATWS Rule Administration Process", December 1988) the text will not be changed, but the following clarification will added.

"These important points are based on SECY-83-293 and the final ATWS Rule, and were applicable at the time those documents were issued. The current applicability of these points needs to consider today's risk-informed environment and changes in plant operation."

As noted, this statement is taken from Section 2.1 of WCAP-11992. WCAP-11992 has been reviewed by the NRC.

Editorial Clarification 3. The TR includes the statement that the ATWS Rule only required the installation of AMSAC for Westinghouse reactors and that "[the acceptability of specific plant conditions as related to the ATWS events is determined within the context of total ATWS core damage frequency, per SECY-83-293." Though the staff agrees that the only requirement for Westinghouse reactors in the ATWS Rule was the installation of AMSAC, the staff has not been able to identify in SECY-83-293 where it states the acceptability of specific plant conditions is solely determined within the context of core damage frequency (CDF). Please clarify the intent of this statement in the TR and/or revise WCAP-15831-P accordingly.

Response: The ATWS Rule is based on a value/impact assessment of several options to reduce ATWS risk to an acceptable level. The SECY-83-293 study used an ATWS "risk" goal of "no more than about 1E-05 per year". Core damage was equated with public risk for the value/impact study. The plant/design options for ATWS event mitigation were developed to reduce core damage frequency (risk) to an acceptable level while considering the cost of implementation. Since the target core damage frequency was 1E-05/reactor year, the acceptability of plant conditions is based on core damage frequency.

No changes to WCAP-15831-P or WCAP-15831-NP will be made based on this comment.

Note that this statement is taken from Section 2.1 of WCAP-11992 ("Joint Westinghouse Owners Group/Westinghouse Program: ATWS Rule Administration Process", December 1988) which was reviewed by the NRC.

Editorial Clarification 4. There is an incorrect statement in Section 2.4.2 of the TR. The statement is: "Several members of the Staff did indicate that even if Reg. Guide 1.174 is used and all the requirements are met, there could be overriding deterministic arguments that guide their final decision." In applying RG 1.174, an applicant must address probabilistic and engineering aspects of the licensing basis change. At the NRC/WOG August 23, 2000 meeting, the staff emphasized the need for the WOG to fully address the deterministic aspects in its TR and not rely solely on probabilistic arguments. Sections 2.2.1.1 and 2.2.1.2 of RG 1.174 indicate that engineering evaluations must be performed to ensure that adequate defense-in-depth and safety margins are maintained. Please revise WCAP-15831-P accordingly.

Response: With this clarification of the Staff's intent, the statement in question will be removed from the WCAP.

<u>Editorial Clarification 5.</u> Table 5-2 identifies 240 transient events that have occurred by "ATWS State" while Table 5-3 identifies only 194 transient events. Please explain the difference in the total number of transient events between these two tables and also please explain why there are a fractional number of events identified for the various ATWS states in Table 5-2. Please revise WCAP-15831-P accordingly.

Response: Table 5-2 of the WCAP provides the trip frequency for all power levels. The total number of trips in this table is 240. Table 5-3 of the WCAP provides the fraction of trips in 30 day intervals and is used to determine the trip distribution over the fuel cycle. The total in this table is 194. This value only considers trips when the power level is greater than or equal to 40%. From Table 5-2 the number of trips with a power level greater than or equal to 40% is 202. This includes 8 trips that occurred after 18 months in the fuel cycle. Subtracting these 8 trips from the 202 trips leaves 194 trips which matches the total on Table 5-3. These eight trips were due to plants with significant downtime following startup after a refueling so the cycle time ran past 18 months. To maintain a set of data to determine the trip distribution over an 18 month fuel cycle, these were eliminated. Additional text will be added to Section 5.1.1.11 of the WCAP to explain this difference.

Table 5-2 provides the number of events in the five ATWS states. Several of these are fractional numbers. Calculation of these values is demonstrated in Section 5.1.1.2 of the WCAP. To recap, the total number of events over all power levels is 240. Thirty-eight for these occurred with the power level < 40% and 24 occurred with the power level ≥ 40% and < 95%. The fractions arise when these numbers are divided between startup and shutdown trips. WCAP-14333 collected information on startup and shutdown trips, and provides the probability of a reactor trip on startup as 0.088 and on shutdown as 0.068. These two values were then used, as shown in Section 5.1.1.2, to divide the number of trips in the two power level ranges between startup and shutdown trips, which resulted in fractional number of events.

Editorial Clarification 6. In Section 8.2 of the TR, the clarifying bullet regarding when the engineered safety features actuation system (ESFAS) is credited seems to be internally inconsistent and confusing. The first sentence states that ESFAS is only credited if the reactor trip signal failure is not a common cause failure (CCF) that can also be associated with the ESFAS signal. However, the second sentence states that the ESFAS signal is only credited if the reactor trip fails due to failure of the control rods to fully insert into the core, which the staff assumes is referring to top event CR. Please clarify when ESFAS is and is not credited in the ATWS probabilistic analyses and revise WCAP-15831-P accordingly.

Response: It is assumed that if the reactor trip signal fails, then the ESF actuation signal also fails. If the ESF actuation signal was available, then the AMSAC signal would not be necessary. But due to the potential for common cause failures, it is assumed that the ESF actuation signal will not be available whenever the reactor trip signal fails. Therefore, the ESF actuation signal is only credited when the ATWS event occurs due to the control rods failing to drop into the core (mechanical failure) given a reactor trip signal has been generated. The top event modeling the control rods failing to drop into the core is CR.

Additional text will be added to Sections 8.2 and 5.1.1.1 of the WCAP to further explain this modeling.

__Editorial Clarification 7.__ The relationship between top events CR and CRI needs to be clarified throughout WCAP-15831-P in accordance with the following specific comments:

__Editorial Clarification 7.a.__ The phrase "control rod insertion" is not used consistently in the TR. In some cases it refers to top event "CRI" and in other cases it refers to top event "CR." Top events "RT" and "OAMG" also play a role in success or failure of control rod insertion. In particular, on page 2-3 it states that the UET is determined based on the "... success or failure of control rod insertion (CRI) ... In this case, CRI is equated to 72 steps insertion of the lead bank." However, on page 8-3 the first bullet states "Control rod insertion (CR) is addressed following success of the reactor trip signal (RT) or failure of reactor trip signal and success of the operator to trip the reactor from the motor-generator (MG) sets (OAMG)." Since these top events represent different conditions, it is important to make sure that the text is clear. Please revise WCAP-15831-P accordingly.

Response: Throughout the WCAP, CRI is defined as the action (manual or automatic) to drive the control rods into the core. Success of this action provides 72 steps (negative reactivity) from the lead bank. CR is defined as a sufficient number of control rods fall into the core to shut down the reactor. On page 2-3 of the WCAP, the phrase "success or failure of control rod insertion (CRI)" is first introduced. In the following sentence it is stated that successful CRI is equated to 72 steps insertion from the lead bank. This is consistent with the above definitions. For clarification purposes, the words "via the rod control system" have been added to the phrase "success or failure of control rod insertion (CRI) <u>via the rod control system</u>" on page 2-3. Similar changes will be made at other places in the WCAP to distinguish between CRI and CR.

__Editorial Clarification 7.b.__ It is noted in the TR that "... it is not necessary to address CR following success of CRI. The probability of rods failing to insert is assumed to be included in the probability of CRI failing (CR is very small compared to CRI)." The latter sentence may be true, but that does not make the former sentence true. This logic infers that there are no means of the rods failing to insert, if the actions identified in CRI are successful. However, CRI success is only dependent on the mode of the rod control system and, if it is in manual, the successful actions of the operators. It does not include the potential for the rods to fail to insert even though the system is in automatic or the operators take the correct actions. If actions related to CRI are successful, there is still the chance that the control rods will not insert. Please revise WCAP-15831-P accordingly.

Response: The latter sentence, "The probability of rods failing to insert is assumed to be included in the probability of CRI failing (CR is very small compared to CRI).", explains why it is not necessary to address CR in the event tree (the former sentence, "... it is not necessary to address CR following success of CRI."). It is not stating that the control rods cannot fail to move into the core if the operator takes the action or if the rod control system starts to drive the control rods into the core. Since the value for CR failing is 1.2E-06/d and the value for CRI failing is 0.1 adding CR into CRI still gives 0.1. Therefore, CR is not explicitly addressed in the model. This is explained in the WCAP in the 3rd paragraph of Section 5.1.1.5 and the last paragraph of Section 5.1.1.6.

The sentence identified above in the Editorial Clarification is at the end of Section 8.2.5. The text will be changed to the following:

> Note that it is not necessary to <u>explicitly</u> address CR following success of CRI. <u>It is understood that the control rods still need to move into the core, but</u> the probability of the rods failing to insert is assumed to be included in the probability of CRI failing (CR is very small compared to CRI).

<u>**Editorial Clarification 7.c.**</u> In Section 8.2.5 of the TR, it is stated that even "[if CR fails, it is assumed that sufficient rods have inserted to be equivalent to 72 steps of D-bank insertion ..." It is also stated that failing to get this amount of insertion "... is not credible." This assumption limits the pressure peak and resulting consequences of the ATWS event. The staff does not accept this assumption without significant supporting justification that there are no failure modes that could effectively result in no insertion. The staff believes, absent additional justification, that if top event CR fails, it should be assumed that no rods insert, instead of crediting some insertion even in failure, and the resulting analyses and configuration management approach should be based on this assumption (i.e., no insertion at all if top event CR fails). Please revise WCAP-15831-P accordingly.

Response: Assuming, as the NRC suggests, that no rods insert if CR fails is extremely conservative and could lead to inappropriate conclusions and decisions based on the model. The failure probability associated with CR is 1.2E-06/demand and corresponds to the failure probability for ten or more of 50 control rods to insert. This is taken from NUREG/CR-5500, Vol. 2 ("Reliability Study: Westinghouse Reactor Protection System, 1984 – 1995", December 1998). In this NUREG, the basic event ROD (the equivalent of CR in the WCAP) is defined in Table 5-2 as "Failure of RCCA/CRDM, resulting in failure of RCCA to insert into the core". In Appendix E (Section E-4) of this NUREG, it is noted that "For most transients, the insertion of a few rods is sufficient to shut down the reactor, e.g., less than ten for a mild transient. For others, it requires more rods to insert." It is further noted in Appendix E, with regard to an ATWS event, "that PWR overpressurization can be prevented by a relatively few control rods successfully inserting…".

Since the failure criteria for CR is ten or more control rods (out of 50) fail to insert, there will be a significant negative reactivity insertion even if CR fails. Since there will be a significant number of control rods inserting, the ATWS overpressurization will be partially or fully mitigated, depending on the time in life, auxiliary feedwater flow, and pressure relief capability. To simplify the model, it is assumed that this negative reactivity insertion achieved following CR failure, although not sufficient to shut down the reactor, is the equivalent of 72 steps of control rod insertion from the lead bank and the UETs associated with 72 steps insertion from the lead bank are used when CR fails. To assume no control rods insert would be much too conservative.

<u>**Editorial Clarification 7.d.**</u> The text and logic modeling would be more clear and concise if top events RT and OAMG were combined into a single top event (RT/OAMG) in the ATWS event tree to address scram success/failure and top event CRI were to address initial/partial control rod insertion success/failure. With this approach, the specific component and action failure combinations would need to be addressed via a fault tree logic model, including current top event

CR as a potential failure mechanism of both of these top events. Under this streamlining of the logic model, success of the top event RT/OAMG would result in no ATWS (i.e., success sequence) and failure would lead to the CRI event. CRI success would mean there would be initially 72 steps of insertion of the lead bank to help mitigate the pressure resulting from the ATWS and the rods would continue to be inserted so that the reactor would be maintained subcritical (i.e., no need to address the long term shutdown (LTS) top event for these sequences). CRI failure would mean that there is no rod insertion and the LTS top event would need to be addressed for these sequences. This approach would seem reasonably realistic and it would not be necessary to provide additional justification for the current model assumption that even with failure of CR there are 72 steps of insertion as requested by Item 7c above. Please revise WCAP-15831-P accordingly.

Response: There are two potential problems with following the suggested approach of combining RT and OAMG (and CR) under a single top event. The first is in regard to crediting ESFAS as a means to start AFW and trip the turbine. If RT is successful and CR fails, then the ESF actuation signal and AMSAC can both can be credited with actuating auxiliary feedwater and tripping the turbine. If RT fails, OAMG is successful, and CR fails, then it is assumed that the ESF actuation signals have also failed, consistent with the standard ATWS event progression, and only AMSAC can be credited for actuating auxiliary feedwater and tripping the turbine. This logic is clear with the approach used in the WCAP.

The second potential problem is related to failure of CR. As discussed in the response to Editorial Clarification 7.c, failure of CR still results in a significant negative reactivity insertion. It appears the proposed approach would not credit this negative reactivity insertion and require that CRI be addressed. This would be a very conservative approach. In addition, it is not clear that if CR failed that CRI (control rod drive system) would be able to insert the control rods into the core. Using the approach in the WCAP, no credit is taken for CRI if CR fails.

Based on the above, no changes are planned for the ATWS model described in the WCAP.

<u>Editorial Clarification 8.</u> Section 10 of the TR discusses actions a licensee must take to demonstrate that transitioning to a high reactivity core is acceptable, given that the plant is "not consistent with the bases for the ATWS rule." Because some licensees currently operate with a positive moderator temperature coefficient and can at times operate in some of the adverse plant configurations analyzed in this TR (e.g., PORVs blocked, AFW train out of service, etc.), this discussion might be interpreted to imply that licensees are currently operating in a manner not consistent with the ATWS rule. Please discuss how licensees will track UET to ensure that the bases for the ATWS rule are maintained and revise WCAP-15831-P accordingly.

Response: Licensees will use the ATWS Configuration Management Program (CMP), discussed in the response to Technical Clarification 1.a, to track the plant operating configuration throughout the cycle and compare the current configuration to a set of plant configurations associated unfavorable exposure times (UETs). The UETs define the time during the cycle when the ATWS pressure transient will exceed 3200 psi. The UETs are dependent on control rod insertion (either 72 steps from the lead bank or none), auxiliary feedwater flow (100% or 50%), and pressure relief capability (number of blocked PORVs). The objective is for the licensee to operate the plant in a configuration which is favorable to the mitigation of the ATWS pressure transient. This is defined by the UETs.

The ATWS CMP will most likely, although not necessarily, be incorporated into the Configuration Risk Management Program licensees use to the address the Maintenance Rule. The CRMP tracks the availability of components and this information can be used in the ATWS CMP. The equipment that needs to be considered is:

- Auxilary feedwater system
- Pressurizer PORVs
- Pressurizer safety valves
- AMSAC
- Steam stop and control valves
- Rod control system (automatic or manual)

To accomplish this tracking, the ATWS CMP will need the following capabilities:

- Identify plant configurations that do not maintain defense-in-depth to an ATWS event. This will be based on equipment important to mitigation of the ATWS pressure transient and the UETs.
- Track the time for individual occurrences when the plant is in an unfavorable plant configuration.
- Track the cumulative time per cycle when the plant is in an unfavorable plant configuration.
- Provide information on the length of time remaining in the UET for plant configurations.
- Provide compensatory actions to take if the unfavorable condition cannot be exited prior to expiration of the time allowed in the unfavorable configuration.

Not all the time in a UET will be tracked against the allowed cumulative total. As discussed in response to Technical Clarification 1.e, some surveillance requirements are necessary to demonstrate equipment operability for design basis events. These surveillance requirements can impact the availability of equipment to mitigate an ATWS event, but since the design basis events contribute greater to risk than ATWS, these surveillance requirements will be performed on schedule. As shown on Table 2, these surveillances to do not contribute significantly to equipment unavailability, therefore, surveillances required to demonstrate equipment operability will not be counted in the cumulative total. But, if the ATWS mitigation equipment is out of service for preventive or corrective maintenance activities, and this places the plant in a unfavorable configuration, then this time will be counted in the cumulative total.

This will be discussed in the revision to the WCAP.

Response to NRC's Supplementary Request for Further Clarifications Made at the March 16, 2004 NRC/WOG Meeting on WCAP-15831-P

Supplementary Clarification 1: How will Technical Specification Surveillance Requirements be addressed with regard to the time allowed in an unfavorable configuration and is this a significant amount of time?

Response: As discussed in the response to Technical Clarification 1.e, entries into unfavorable configurations to meet Technical Specification surveillance requirements are acceptable. Some of the equipment important to mitigation of an ATWS pressure transient is also important to mitigation of other design basis events. These design basis events typically are larger contributors to plant risk than the ATWS event, therefore, it is important to maintain the equipment operability for design basis event mitigation. The surveillance requirements demonstrate equipment operability, therefore, it is recommended that they continue to be completed at the specified interval.

If equipment inoperability due to surveillance requirements moves the plant into an unfavorable configuration, then simultaneous test and maintenance activities that compromise the reactor trip system availability or that place the plant in a higher trip potential configuration should be rescheduled to when the plant returns to a favorable configuration, i.e., until completion of the surveillance.

The surveillance requirements identified in the Technical Specifications (NUREG-1431) for these systems/components are summarized on Table 1 along with surveillances required by plant procedures. Similar information is provided on Table 2 for Braidwood. Table 2 also includes the times the surveillance requirements cause the system/component to be inoperable with regard to ATWS event mitigation. It is concluded from this that the time these systems/components are unavailable to meet surveillance requirements is small in comparison to the (proposed) 30 day total time allowed in an unfavorable configuration. Therefore, it is proposed that this time does not need to be tracked against the total time allowed in unfavorable configurations, if it does place the plant in an unfavorable configuration.

Supplementary Clarification 2: How much time is available for an operator to trip the reactor by interrupting power to the MG sets? The MG set coast down time needs to be accounted for in this assessment.

Response: The time available for the operators to taken action from the start of the event until the RCS pressure increases to 3200 psig is dependent on the core reactivity (low, high, bounding), the available pressure relief, and the AFW flow. For the low reactivity core, without credit for control rod insertion of 72 steps, the time varies from 103 seconds to 111 seconds. For the bounding reactivity core, without credit for control rod insertion of 72 steps, the time varies from 93 seconds to 100 seconds. The times for the high reactivity core lie between these two ranges of time.

The time required for the coastdown of the motor-generator sets is the time from interruption of power to the MG sets until the power decays sufficiently to allow the CRDMs to release the control rods, and the control rods to drop into the core. There is a minimum specified time of 1 second to eliminate reactor trips on momentary losses of power, but no requirements on the maximum length of time. Therefore, licensees implementing this compensatory action will need to document that sufficient time exists for the operator to take the action to interrupt power to the MG sets and for the MG sets to coast down, and release the control rods, within approximately 90 seconds. Alternate approaches to interrupting power to the CRDMs may be pursued if the MG set coast down time does not meet this requirement.

Supplementary Clarification 3: With regard to the impact on UETs, how will the downtime in the cycle and operation at less than 100% power be addressed.

Response: As stated in the response to Technical Clarification 1.d, effective full power days of operation will be the basis for the ATWS CMP. Downtime and operation at less than 100% power will be accounted for through the use of effective full power days.